IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	William W. Feng, et al.
Title:	Method and system for numerically simulating foam-like material in finite element analysis
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Group Art Unit:	2123
Docket No:	LSTC-004
Customer No:	**37804**

February 1, 2006

AFFIDAVIT under 37 CFR §1.132

The undersigned swears and states that:

1. My name is Dr. Kelly S. Carney, I live at 34489 Grafton Eastern Rd., Grafton, Ohio. I was born in Lansing, Michigan and attended school in Michigan and Ohio. I hold a Ph. D degree in Engineering Mechanics from Case Western Reserve University.

2. I am currently working for NASA Glenn Research Center as an Aerospace Engineer performing ballistic impact analysis for a variety of applications, including aircraft engines and launch vehicles.

3. All of the prior art solutions for numerically simulating foam-like material (e.g., rubber) in a finite element analysis program module require users to define the energy density function (i.e., stress function recited in claim 1 of the above identified patent application) for the foam material. The energy density function (i.e., equation 110 in FIG. 1) is listed as follows:

$$W = \sum_{i=1}^{3} \sum_{j=1}^{m} \frac{\mu_j}{\alpha_j} \left[(\lambda_i^{\alpha_j} - 1) + \frac{1}{n} (J^{-n\alpha_i} - 1) \right]$$

4. In all of the prior art solutions, the user must determine the coefficients n, α_j, and μ_j in the energy density equation, such that the simulation results from the finite element analysis program module match the test data. This is a reverse engineering process that in most cases turns out to be prohibitively slow. For example, it can take several weeks for an industrial application to converge to a set of coefficients that fits the test data.

5. In many incidences that there is not a set of coefficients can fit the test data.

6. The present invention disclosed in the above identified application allows the user to input test data (i.e., engineering stress versus engineering strain) in a tabulated manner without the requirement of reverse engineering of non-linear fitting of coefficients in the prior art solutions.

7. The present invention converts the tabulated test data from the user input into a tabulated definition of the energy density function (i.e., said calculating a plurality of stress function $f(\lambda)$ values step in claim 1).

8. The input data preparation time has reduced from several weeks based on the prior art procedure to a few hours based on the present invention.

9. The conversion from the test data to a tabulated energy density function has never been published in any academic research papers. The conversion is not obvious for any person skilled in the art.

10. The procedure disclosed in the present invention is not an internal fitting of the coefficients.

11. The procedure disclosed in the present invention is an exact match of the test data by the simulation results.

12. None of the prior art solutions can provide an exact fit of the test data.

13. The procedure disclosed in the present invention allows a number of industrial applications to include foam-like material in their simulation due to the drastic time reduction of the input data, which is not practical with the prior solutions.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statement were made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the Application or any patent issued thereon.

Signature: Kelly S. Carney **Date:** FEB. 1, 2007

PRINT NAME: KELLY S. CARNEY

State of California)
) ss:
County of Alameda)

On this 1st day of February, in the year 2007, before me, Denette J. Grebe, Notary Public, personally appeared Kelly S. Carney personally known to me (or proved to me on the basis of satisfactory evidence) to be the person whose name is subscribed to the within instrument, and acknowledged to me that he/she executed the same in his/her authorized capacity(ies), and that by his/her signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

WITNESS my hand and official seal.

Notary Signature Denette J. Grebe (SEAL)

DENETTE J. GREBE
Commission # 1679774
Notary Public - California
Alameda County
My Comm. Expires Aug 2, 2010